

IRRIGATING THE YAKIMA INDIAN RESERVATION.

LETTER

FROM

THE SECRETARY OF THE INTERIOR,

TRANSMITTING

A REPORT AND PLANS PREPARED BY THE SUPERINTENDENT OF IRRIGATION FOR DISTRICT NO. 1, IN THE INDIAN SERVICE, ON PROVISIONS FOR WATER SUPPLY FOR FORTY ACRES OF EACH INDIAN ALLOTMENT ON THE YAKIMA INDIAN RESERVATION, WASHINGTON.

JANUARY 5, 1915.—Referred to the Committee on Indian Affairs, and ordered to be printed with illustrations.

DEPARTMENT OF THE INTERIOR,
Washington, January 4, 1915.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

SIR: The act of August 1, 1914 (Public No. 160), provides a water supply for 40 acres of each Indian allotment on the Yakima Indian Reservation, Washington, and requires that the Secretary of the Interior shall prepare and submit to Congress the most feasible and economical plan for the distribution thereof in connection with the present system and with a view to reimbursing the Government for any sum it may have expended or may expend for a complete irrigation system for said reservation.

In compliance with this requirement I invite attention to a report dated November 18, 1914, together with attached drawings, prepared by the superintendent of irrigation for district No. 1 in the Indian Service. This report is based mainly upon a former report of the Supervising Engineer of the Reclamation Service, the superintendent of the Yakima Indian School, and the superintendent of irrigation in the Indian Service, transmitted to Congress with department letter of January 22, 1913, and printed as House Document No. 1299, Sixty-second Congress, third session, and contemplates development as outlined generally therein.

It is the conclusion of the engineers who have studied the situation that this plan presents the most advisable, economical, and feasible

system for distributing water for the irrigation of 40 acres of each Indian allotment in the territory under consideration and the remaining area of allotted land in areas contiguous to and interspersed among the 40-acre tracts for which a water supply is to be acquired by the owners thereof.

Since the submission of the report printed, the conditions have not materially changed, and the proposed construction and enlargement appears to be fully warranted by the conditions and necessary for the proper utilization of the water supply provided by Congress.

Respectfully,

FRANKLIN K. LANE.

DEPARTMENT OF THE INTERIOR,
UNITED STATES INDIAN SERVICE,
IRRIGATION AND DRAINAGE;
North Yakima, Wash., November 18, 1914.

The honorable COMMISSIONER OF INDIAN AFFAIRS,
Washington, D. C.

SIR: In compliance with office letter of August 25, approved by the Department of the Interior August 27, 1914, I submit herewith a report on the most economical and feasible method for irrigating the 120,000 acres of the Wapato project, Yakima Indian Reservation, about five-sixths of which is now allotted to Indians, the remaining one-sixth having passed into the hands of whites. Before beginning the description of the proposed system I will give a brief description of the present system.

The first irrigation work constructed by the Government for its wards was undertaken in 1896, when the Old Reservation Canal was begun. Nearly \$20,000 of the funds spent in building this canal was derived from the sale of the Wenatshapam fisheries. This Old Reservation Canal is not constructed along proper lines, it being at right angles to the contours and diagonally across the sections. Its fall is excessive, averaging 3 feet in 1,000, and entirely in the gravel sub-soil, and consequently it is very wasteful on account of seepage losses, to the detriment of the land below, as well as the adjacent land.

This canal has a very faulty headworks and it is impossible to divert sufficient water for the 11,000 acres under it at times of low water. The head gate is in very bad repair, and in fact the water in the entire length of this canal is not under proper control, as there are no checks or drops.

In 1903 the canal known as the New Reservation Canal was begun and has been continued when funds were available since that date. Nearly 26,000 acres are now irrigated from it. This canal is constructed along more economical and efficient lines, practically on a contour. The head gate is of masonry walls with timber curtain walls, gates, and floor. The masonry is still in excellent condition, but the timber parts should be replaced by concrete. There is no diversion dam at this head gate, which has necessitated expensive work annually in order to divert sufficient water to irrigate the land. During the season of 1914 the water shortage occurred about June 20, which would have resulted in serious loss to crops had we not foreseen the probable shortage and placed the drag line excavator in

operation early in June to clean out the channel for about 1,000 feet from the river to the head gate. The water shortage would have occurred in spite of the fact that about 2,000 cubic feet per second were being wasted into the Columbia River. The river channel is changing gradually above the point of diversion, and until the stream is controlled at this point by a diversion dam it will be necessary to do expensive temporary work annually. This work is expensive, due to the fact that in order to have the work completed in time to prevent a water shortage it must be done when there are several thousand cubic feet per second of water flowing in the river. The main laterals from this canal cross the contours at right angles, consequently numerous drops are necessary; these are, however, too small to develop power for pumping on to the higher allotted lands. Owing to the rapid fall of the land, the laterals extend well into the gravel for some distance below each drop, making the seepage losses very heavy, to the detriment of adjacent land and causing it to subirrigate, and in places the land is becoming too boggy to harvest the crops raised. The swamped, subirrigated, and alkali areas along Toppenish Creek had become so large, 30,000 to 40,000 acres, that \$250,000 was appropriated for drainage work in the spring of 1910 and the funds expended in the construction of 42 miles of drainage canals and the necessary structures. These drains are very efficient, carrying off an average of 200 cubic feet of water per second throughout the year. The lands that were formerly tule beds and swamps are now too dry for farming purposes without irrigation, but with irrigation it is believed these lands will become very productive. The necessity for other drains is apparent, as shown by surface conditions and measurements of wells over the Wapato project during the past two years. The proposed system for irrigating the entire Wapato project contemplates the construction of a drainage system in connection with the irrigation system. The entire irrigation system now in operation is very wasteful to the detriment of the land, and in poor repair, and is not constructed along economical lines, either in the use of water or land occupied by the ditches themselves. The main laterals, however, can be placed in good repair where they can be used as canals and laterals or used as drains by taking out the various drops.

The plan proposed for the complete Wapato project follows very closely the one described in House Document No. 1299, Sixty-second Congress, third session, beginning on page 27 and ending in the middle of page 36 with the exception of the storage item. The plan now submitted is changed only in minor details, but will probably be subject to further changes as the construction work proceeds.

PROPOSED PLAN TO CONSTRUCT AN IRRIGATION SYSTEM FOR 120,000 ACRES IN THE WAPATO PROJECT.

The act of August 1, 1914, provides as follows:

It appearing by the report of the Joint Congressional Commission created under section twenty-three of the Indian appropriation act approved June thirtieth, nineteen hundred and thirteen (Senate Document Numbered Three hundred and thirty-one, Sixty-third Congress, second session), that the Indians of the Yakima Reservation, State of Washington, have been unjustly deprived of the portion of the natural flow of the Yakima River to which they are equitably entitled for the purposes of irrigation, having only been allowed one hundred and forty-seven cubic feet per second.

the Secretary of the Interior is hereby authorized and directed to furnish at the northern boundary of the Yakima Indian Reservation, in perpetuity, enough water, in addition to the one hundred and forty-seven cubic feet per second heretofore allotted said Indians, so that there shall be, during the low-water irrigation period, at least seven hundred and twenty cubic feet per second of water available when needed for irrigation, this quantity being considered as equivalent to and in satisfaction of the rights of the Indians in the low-water flow of the Yakima River and adequate for the irrigation of forty acres on each Indian allotment; the apportionment of this water to be made under the direction of the Secretary of the Interior, and there is hereby authorized to be appropriated the sum of \$635,000 to pay for said water, to be covered into the reclamation fund; the amount to be appropriated annually in installments upon estimates certified to Congress by the Secretary of the Treasury. One hundred thousand dollars is hereby appropriated to pay the first installment of the amount herein authorized to be expended, and the Secretary of the Interior is hereby directed to prepare and submit to Congress the most feasible and economical plan for the distribution of said water upon the lands of said Yakima Reservation in connection with the present system, and with a view to reimbursing the Government for any sum it may have expended or may expend for a complete irrigation system for said reservation.

This act provides for the irrigation of 40 acres of each Indian allotment. It would not be economical or feasible to construct a project for the irrigation of only 40 acres of each allotment, as the majority of the allotments are 80 acres, and for that reason the proposed plan will provide for the irrigation of the entire 120,000 acres.

DIVERSION DAM.

There are two possible dam sites; one, shown on the map as B line, crossing the river opposite the south wall of the present head gate. The first 200 feet across the channel on the west side of the island to be a concrete weir; that part of the dam on the island to be an earth and gravel dike, riprapped on the upstream side and approximately 400 feet long; from the east side of the island there will be a concrete weir 420 feet long across the main channel of the river. From the east bank of the river a dike will extend to the hill, approximately 1,000 feet, making a total weir length of 620 feet and 1,400 feet of dike.

Line A would cross the river at a point about 800 feet above the present head gate. The concrete weir would be 500 feet in length and 850 feet of earth and gravel dike extending to the hill on the east.

ADVANTAGES OF LINE B.

If this line is used, the present head gate, by replacing the timber part with concrete, will divert sufficient water for the entire 120,000 acres. At times of extreme high water the depth over the diversion weir would be 8.2 feet, discharging 60,000 c. f. s. On account of its location it would be less difficult to construct, the stream being diverted to one side of the island while the dam was being constructed on the other side. The line A, while shorter than B line, would necessitate the construction of a head gate where shown on the map and considerable riprap and protection to the dike on the east side of the channel extending to the present head gate. The total cost of a dam on line A would be about \$10,000 less than on line B, but its disadvantages are, first, it would back the water up 1.3 feet higher at times of high water, thereby flooding more land above and probably causing damages to the amount of more than the difference in cost of the two dams; second, it would be more difficult to construct owing to the cramped area at the west end of the dam, there being

practically no place for equipment on account of the two railroads and county highway using all the space between the hill and river.

Neither site involves any great engineering problems. The type of concrete weir is shown on the inclosed drawing and will have a concrete cut-off wall as shown, or, if found feasible, sheet piling will be used. On account of the compact, gravelly nature of the subsoil it may not be found feasible to drive sheet piling.

MAIN CANAL AND HEAD GATE.

If the dam is constructed on line A, a new concrete head gate will be built and the present channel properly protected by riprapping the dike on the river side and the channel or canal below the head gate, and the timber part of the present head gate removed and replaced by concrete if deemed necessary for an emergency gate. The canal from this point will be concrete lined around the curve and enlarged to carry 1,500 c. f. s., with a maximum depth of 10 feet. The dimensions will be a bottom width of 40 feet, water depth 10 feet, with side slopes of $1\frac{1}{2}$ to 1. The grade of the canal will be 0.00015 or a fall of 1 foot in 6,667 feet, giving the water a velocity of $2\frac{3}{4}$ feet per second and a capacity of 1,500 c. f. s.

The proposed plan will be to line the earth section of the canal wherever it intercepts the gravelly subsoil with a layer of top or impervious soil 2 feet in thickness to prevent excessive losses of water by seepage.

At a point approximately 4 miles from the head gate the main canal will turn south about 3,000 feet to a point in section 2, T. 11, R. 18, where 1,100 c. f. s. will be dropped 24 feet to generate power for pumping water for 14,000 acres above the gravity canal. There are three other points on this canal where drops will be necessary and a total of 10,944 theoretical horsepower may be developed. It is estimated that only 2,930 horsepower will be required for pumping onto the 14,000 acres above mentioned. The remaining power may be developed as an asset to the project and used for pumping water onto other lands outside the 120,000 acres now being considered. The installation of machinery to develop this remaining power is not included in the estimates, but as power for irrigation pumping is in large and increasing demand in this country and the cost of development little more than the cost of installing machinery, this surplus power should be an asset of considerable value. This canal is designated as power canal in House Document No. 1299, before mentioned, but it is not only a power canal but the main lateral supply canal. Laterals will divert water from this canal at a point below each power drop and will be constructed on a contour. In this manner they can be given the proper grades without the construction of drops or placing the laterals deep in the gravel, which would cause heavy seepage losses. The advantages of these contour laterals are that all the drops are concentrated at four points, making it worth while to develop the power and pump on the higher allotted lands, and being constructed on contours, they will not intercept the gravelly subsoil, except at those places where the gravel is within three or four feet of the surface of the ground, and at these places the laterals will be lined with impervious top soil as described for the main canal.

The laterals for the irrigation of the land west of the power or lateral supply canal will divert water above the four power drops. The soil in this section of the project is very deep and no protection against seepage losses is needed.

DRAINAGE.

The east 90,000 acres of the project will have to be supplied with drainage canals. Practically 30,000 acres have already been provided with drainage canals. The proposed drainage system contemplates the construction of contour drains on the north side of the contour laterals, where deemed necessary, with lateral drains emptying into them from the north at approximately 1 mile intervals. In many cases present canals and sloughs can be used as drains. A drainage system is as necessary as the irrigation system and should be constructed as a part of the irrigation system.

The western 30,000 acres of the project is more rolling and of much deeper soil, and very little drainage will be required.

DUTY OF WATER.

The duty of water is estimated at 4.3 acre-feet, measured at the main-canal head gate, for the total area of 120,000 acres. The irrigation season is from April 1 to October 31; very little water, however, will be required after October 15.

SOIL.

The greater part of the land to be irrigated is volcanic ash soil underlaid with porous gravel varying from 2 to 6 feet beneath the surface for the eastern part of the project and 40 feet in the western part of the project.

LAND VALUES.

Land values in this part of the State of Washington are very high, often raw sagebrush land has sold for \$250 and in many cases the water right has cost \$90 additional per acre. In my opinion, however, the conservative value of the reservation land, when placed under cultivation and irrigation, is from \$125 to \$150 an acre. The land without the possibility of irrigation would be high at \$1.25 an acre. The construction of the project will enhance the value from \$1.25 an acre to \$125 to \$150 an acre, approximately \$12,000,000 for the irrigated area.

A conservative value for the crops raised on the 35,800 acres under the present system this year is \$1,250,000 or \$32.40 an acre, which is a very creditable showing when we consider that about one-eighth of the area was raw sagebrush land cropped for the first time.

ESTIMATED COSTS.

The figures used in the estimated costs of the project are those given in House Document No. 1299, Sixty-second Congress, third session, with the exception of engineering and contingencies, which has been reduced 5 per cent. These estimates are very conservative and based on the excavation being done by teams. From my experience with cost of excavation by machinery, such as was used on

the 42 miles of drainage ditch already constructed, I feel confident that a saving can be made over the following estimates:

Diversion dam and headworks.....	\$78,181
Enlargement of Main canal.....	89,700
Extension A, new reservation canal.....	83,455
Extension B.....	32,835
Extension C.....	15,212
Lateral supply and power canal.....	301,210
First contour lateral with sublaterals.....	77,410
Second contour lateral with sublaterals.....	171,700
Third contour lateral with sublaterals.....	249,260
Fourth contour lateral with sublaterals.....	133,525
Pumping canals and sublaterals.....	124,755
Drainage system.....	401,162
Wasteways.....	50,000
Telephone lines.....	15,000
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Engineering and contingencies, 20 per cent.....	2,139,171
	427,834
	<hr/>
Right of way and damages.....	2,567,005
Cost of present system.....	100,000
	1 ¹ 352,057
	<hr/>
	2,919,062

Expenditures of the Reclamation Service on account of the Wapato project and Yakima Reservation to date are as follows:

Reconnaissance.....	\$3,550.68
Primary triangulation.....	308.11
Secondary triangulation.....	2,271.85
Secondary levels.....	3,555.51
Traverse lines.....	36.59
Broad topography.....	16,290.90
Hydrography.....	17.32
Real estate.....	58.45
Test pits.....	1,402.89
	<hr/>
Total, 1910 survey.....	27,492.30
Diversion dam (1910-1912).....	4,354.38
Original investigations.....	4,618.09
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Investigations on Satus Creek, not a part of the Wapato project.....	36,464.77
	2,464.77
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Total, Wapato project.....	34,000.00

Much of the data obtained by the Reclamation Service will be of great value to the Indian Service and should be turned over to the Indian Service and the Reclamation Service reimbursed a reasonable amount. The topographic maps are of great value to the project, and their cost and the expenditures incident thereto should be reimbursed, but I am of the opinion that the Indian Service would not be justified in paying more than a fair cost for reproducing the work of value to this project. This cost would probably not exceed \$25,000. However, I have added the entire amount to the estimate for the cost of the distribution system:

Total estimate, as shown on p. 12.....	\$2,919,062
Expenditures by Reclamation Service.....	34,000
	<hr/>
	2,953,062

¹ Subject to change. Obtained by adding 1915, \$15,000 appropriation to expenditures to June 30, 1914, as shown on "Summary of Irrigation Data," then deducting \$111,187, the amount expended prior to passage of act of Dec. 21, 1904.

This makes the acreage distribution cost for the 120,000 acres within the project nearly \$25 per acre. This amount is all that would have to be provided by Congress for the entire distribution and drainage systems.

The landowners would have to reimburse the Reclamation Service for storage water for the 48,000 acres of the project not provided with free water. This amount, figured on the same basis as provided in the act of August 1, 1914, is \$11.08 an acre for 48,000 acres. This amount was arrived at by deducting the 147 c. f. s., the amount of water granted the reservation canals in 1905, from the 720 c. f. s., granted by the act of August 1, 1914, leaving 573 c. f. s. for \$635,000, or \$11.082 per c. f. s., and for 480 c. f. s. required will make \$531,936, or \$11.08 an acre. Adding the storage cost to the cost of the distribution system will give for the entire project the following:

Acres.	Distribu-tion system.	Storage.	Cost per acre.
72,000	\$25		\$25.00
48,000	25	\$11.08	36.08

These figures are thought to be very conservative and with appropriations of sufficient size to carry the work to completion in an economical manner, within five or six years, could probably be reduced 8 to 10 per cent.

Section one of the act of December 21, 1904, provides as follows:

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Interior * * * Provided further, That where valid rights have been acquired prior to March 5, 1904, to lands within said tract by bona fide settlers or purchasers under the public-land laws, such rights shall not be abridged, and any claim of Indians to these lands is hereby declared to be fully compensated for by the expenditure of money heretofore made for their benefit and in the construction of irrigation works on the Yakima Indian Reservation.*

Therefore the expenditures made prior to December 21, 1904, should be deducted from the irrigation and drainage expenditures to date and only the remainder reimbursed. The total expenditures to June 30, 1914, as shown by the records of my office, are \$448,244.48. This figure, however, may not agree with the actual disbursements, for the reason that no accurate cost system was in force during early irrigation expenditures. In addition to the above, \$93,859.76 has been expended on maintenance work and should not be reimbursed. You will note that I have added \$352,057 in my estimate as the amount of the present system to be reimbursed. Any error in this figure will not materially affect the acreage cost.

REIMBURSEMENT OF THE PROJECT COST.

The 120,000 acres of land to be irrigated is well able to bear the cost of the entire irrigation system. I therefore recommend that the construction charges constitute a lien upon the land irrigated. This will necessitate new legislation, as the reimbursable drainage and irrigation appropriations heretofore made are to be reimbursed from tribal funds. It is an injustice to the Indians, when only a part of them receive a benefit from an appropriation, to have the funds of

the entire tribe hypothecated. I further recommend that the white land owners, now owning about one-sixth of the land in the entire project, be required to reimburse the cost of the irrigation and drainage system in the manner provided in the amended reclamation act on the 20-year payment plan, the payments to begin the December following the first April that water is delivered by the new irrigation system: I recommend that if the Indians are unable to pay for the cost of the irrigation and drainage systems from their individual funds or from their share of the tribal funds remaining after they are properly equipped for farming on a self-supporting basis, that upon the sale of their allotments the purchaser assume the indebtedness and proceed to pay in the manner similar to the white owners above mentioned.

There is no question but that the land will be worth several times the irrigation cost when placed under cultivation, and the irrigation charges constituting a lien upon the land benefited will result in the payment of the total irrigation charge.

The water users and landowners should sign up for the \$11.08 storage charge and payments made in the manner indicated above for the distribution charges—that is, the charge to constitute a lien upon the land and be repaid on the 20-year installment plan.

Many of the present water users now irrigating their lands have indicated their willingness to begin their payments for storage water for their lands as soon as the charges can be fixed. The majority, however, would receive no benefits until their lands, now in sage-brush, are brought under irrigation.

I recommend that all heirship lands within the project be sold on a 10-year-deferred payment plan so that it may be brought under cultivation and help in the payment of water rights for the heirs and the upkeep of schools and roads by the payment of taxes.

SUGGESTIONS FOR PROPOSED LEGISLATION.

The following suggestions should be considered in preparing legislation for the proposed project:

For beginning the construction of the irrigation and drainage canals and necessary structures on the Wapato project in the Yakima Indian Reservation, Wash., to make beneficial use of the water provided in the act of August 1, 1914, \$400,000, to be immediately available and to remain available until expended. The total cost of the irrigation distribution and drainage systems for the entire 120,000 acres in this project shall not exceed \$3,000,000, including the reimbursable irrigation and drainage expenditures heretofore made. The irrigation and drainage construction charges to constitute a lien upon the lands irrigated, the cost to be reimbursed in 20 annual installments, under such rules and regulations as the Secretary of the Interior may prescribe.

In this manner the total cost will be reimbursed, the white landowners to pay in a manner similar to that provided in the reclamation act and its amendments, and the allottees to pay from any individual funds they may have, from the sale of surplus or inherited lands, or from their share of the tribal funds.

The \$400,000 requested in this report will be expended as follows:

For the construction of a diversion dam and headworks.....	\$78,181
Enlargement of main canal and structures.....	100,000
Construction of first contour lateral and sublaterals.....	77,410
Excavation on lateral supply and power canal.....	119,409
Drainage ¹	25,000
 Total.....	 400,000

Equipment now on the project and available for immediate use consists of one Lidgerwood drag line excavator with 1½-cubic-yard bucket, 1 Marion dipper dredge with 1-yard bucket, two 60-horsepower boilers, one 12-horsepower gasoline engine, one 6-inch sand pump, equipment for 2 blacksmith shops, 6 heavy wagons, 22 Fresno scrapers, plows, scrapers, and miscellaneous equipment.

SUMMARY OF PROJECT DATA.

Total acreage of project.....	120,000
Acreage supplied with free storage water.....	72,000
Acreage required to buy storage.....	48,000
Acreage under gravity canals.....	106,000
Acreage under pumping canals.....	14,000
Acreage owned by Indians.....	100,000
Acreage of deeded lands.....	20,000
Acreage irrigated under present system.....	35,800
Value of irrigated lands within bounds of proposed project..... per acre..	\$125 to \$150
Value of similar land on reservation without possibility of irrigation, per acre.....	\$1.25
Estimated cost of irrigation distribution and drainage system..... per acre..	\$25.00
Estimated cost of storage, 48,000 acres..... do....	\$11.08
Total estimated cost of irrigation, distribution and drainage systems for 120,000 acres, to be provided by Congress and constitute a lien on the land benefited until reimbursed.....	\$3,000,000
Length of irrigation season, from Apr. 1 to Oct. 31..... days..	214
Duty of water, in acre-feet..... per annum..	4.3
Amount of water required, in acre-feet..... do....	513,000
Capacity of main canal and maximum diversion..... c. f. s..	1,500
Average elevation of project above sea level..... feet..	850
Average annual rainfall..... inches..	7

Range of temperature from 15 to 110°.

Crops raised, Grains: Alfalfa and other hay, corn, potatoes, hops, melons, truck, apples, peaches, pears, plums, cherries, and berries of all kinds.

Railroads.—The Northern Pacific and Oregon & Washington Railroad & Navigation Co., main line and branches, run through the project. No farm unit is more than five and a half miles from a railroad.

Estimated value of surplus water power.....	\$500,000
Amount of appropriation requested to be made immediately available and for fiscal year 1916.....	\$400,000

Attached hereto are various maps and drawings which illustrate the various features mentioned in this report.

Very respectfully,

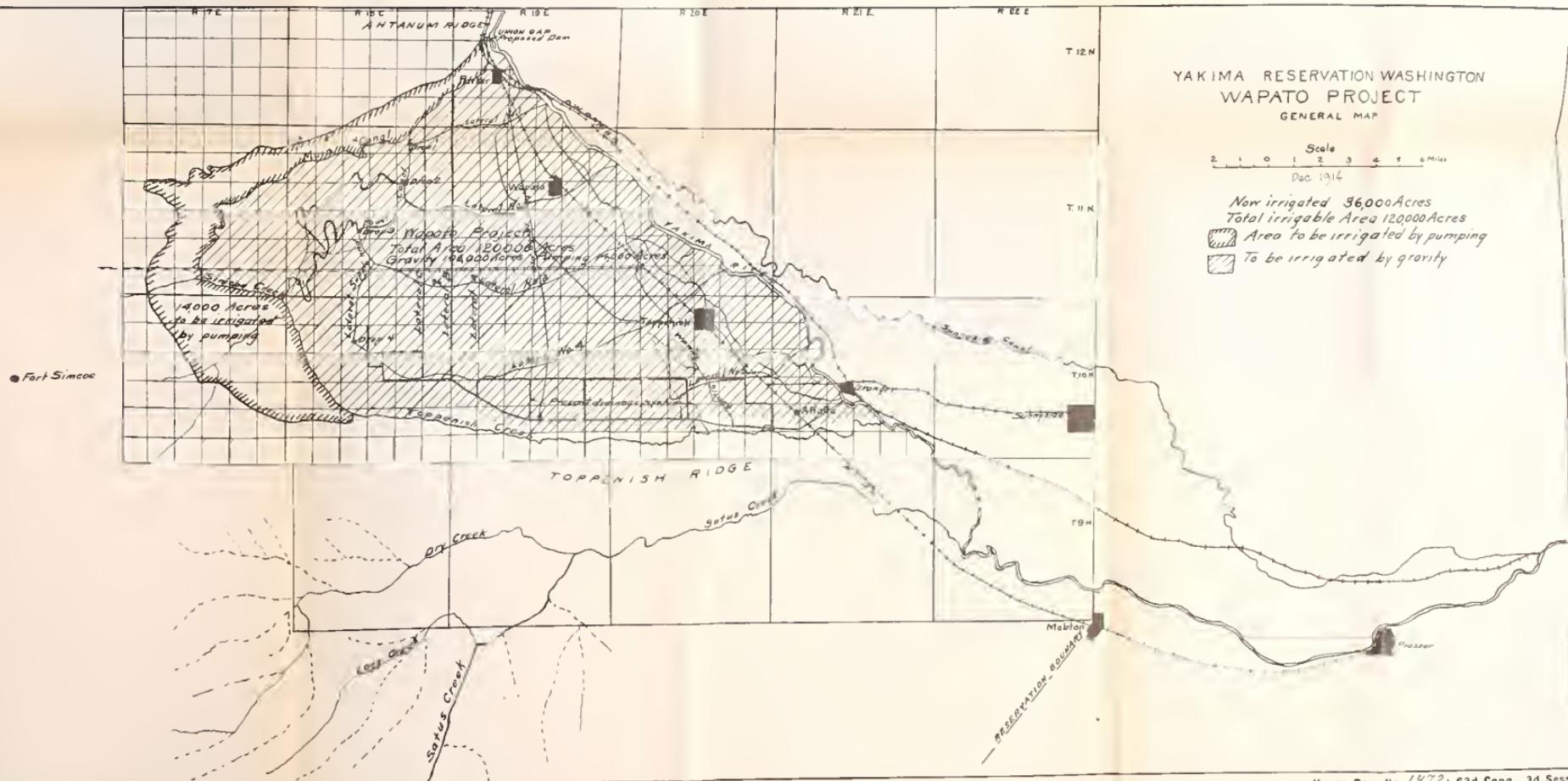
L. M. HOLT,
Superintendent of Irrigation.

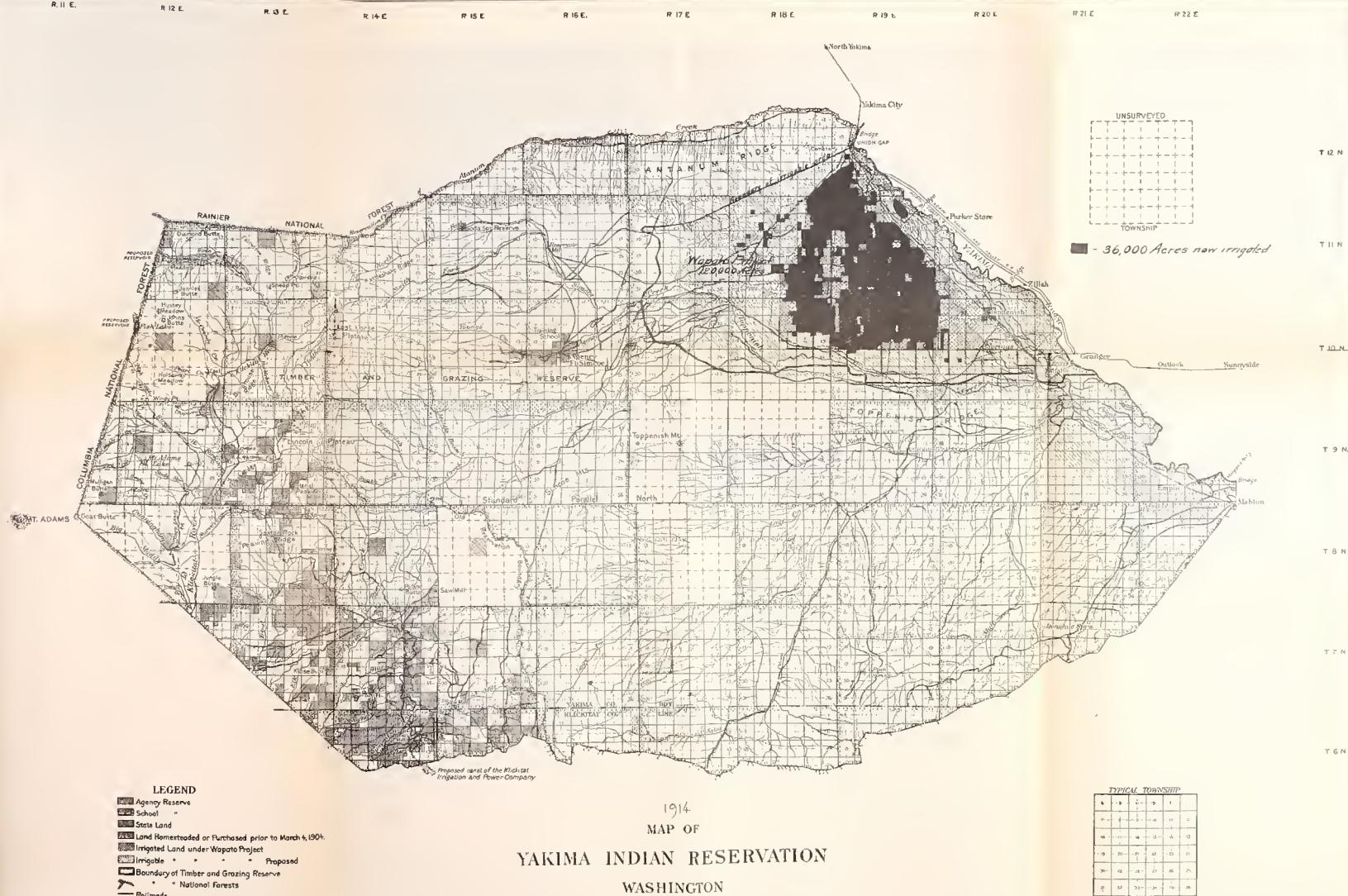
¹ Drainage necessary to save land now threatened under the present irrigation system.

YAKIMA RESERVATION WASHINGTON
WAPATO PROJECT
GENERAL MAP

Scale
2 1 0 1 2 3 4 5 6 Miles
Dec. 1914

Now irrigated 36,000 Acres
Total irrigable Area 120,000 Acres
■ Area to be irrigated by pumping
□ To be irrigated by gravity





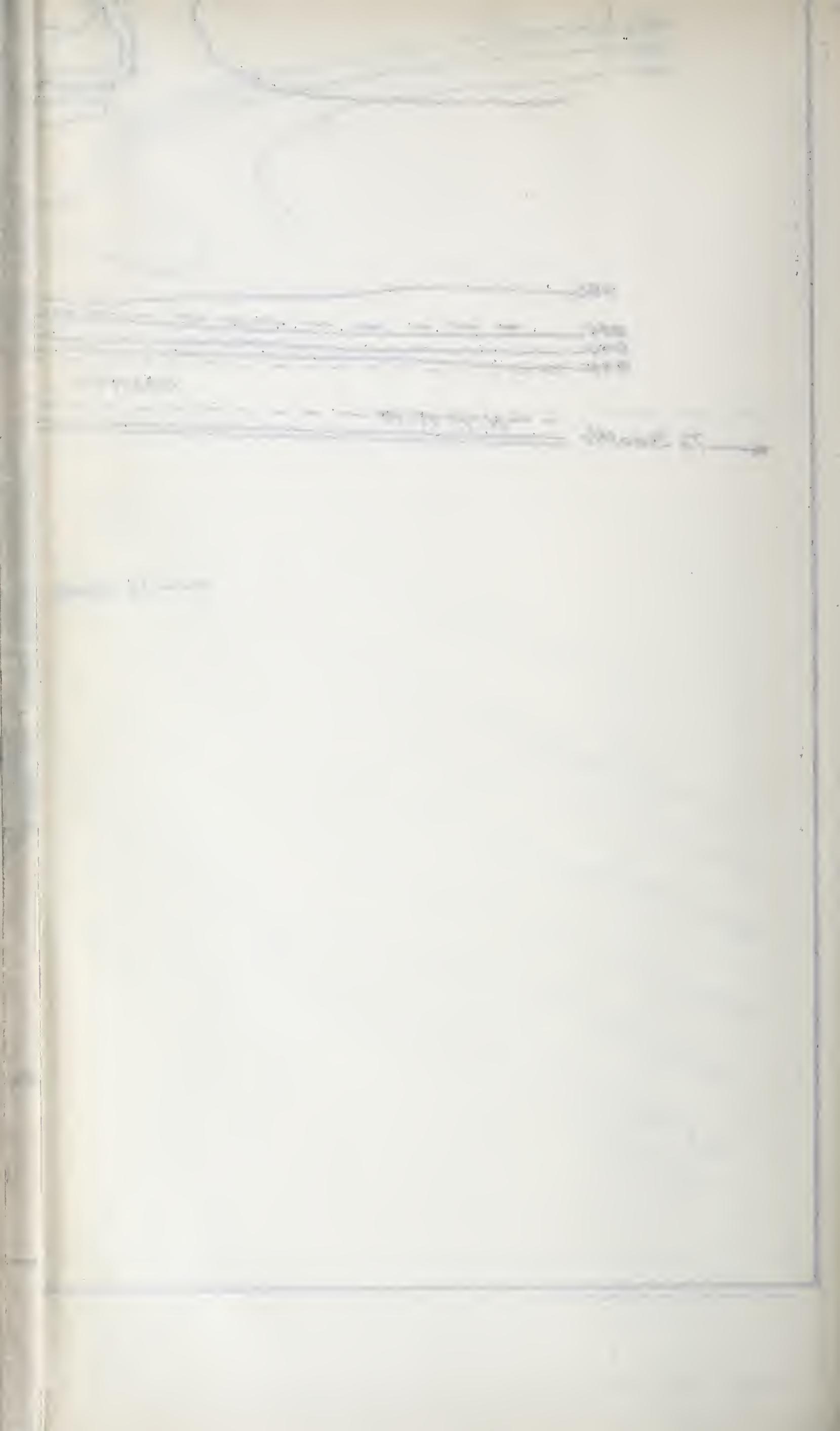
1914
MAP OF
YAKIMA INDIAN RESERVATION
WASHINGTON

LEGEND

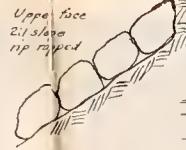
- Agency Reserve
- School
- State Land
- Land Homesteaded or Purchased prior to March 4, 1903
- Proposed Irrigated Land under Wapato Project
- Proposed Irrigated Land
- Proposed
- Boundary of Timber and Grazing Reserve
- National Forests
- Railroads

TYPICAL TOWNSHIP

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20



9470 Top of proposed site



9446 Water surface above dam with estimated maximum flood of 60,000 cfs

9459 Top of wall N P Ry. at headgate

9429 Top of masonry walls present headgate

940

9376 Bridge seat, railway bridge

9364 Crest of proposed dam and high water surface in canal

930

9324 Top of proposed gate openings

930 Approximate present low water surface at dam site

920

9262 Floor of present headgate

9250 Bottom of channel in front of headgate

SECTION OF EARTH DIKE
Showing position in regard to dam section

15'

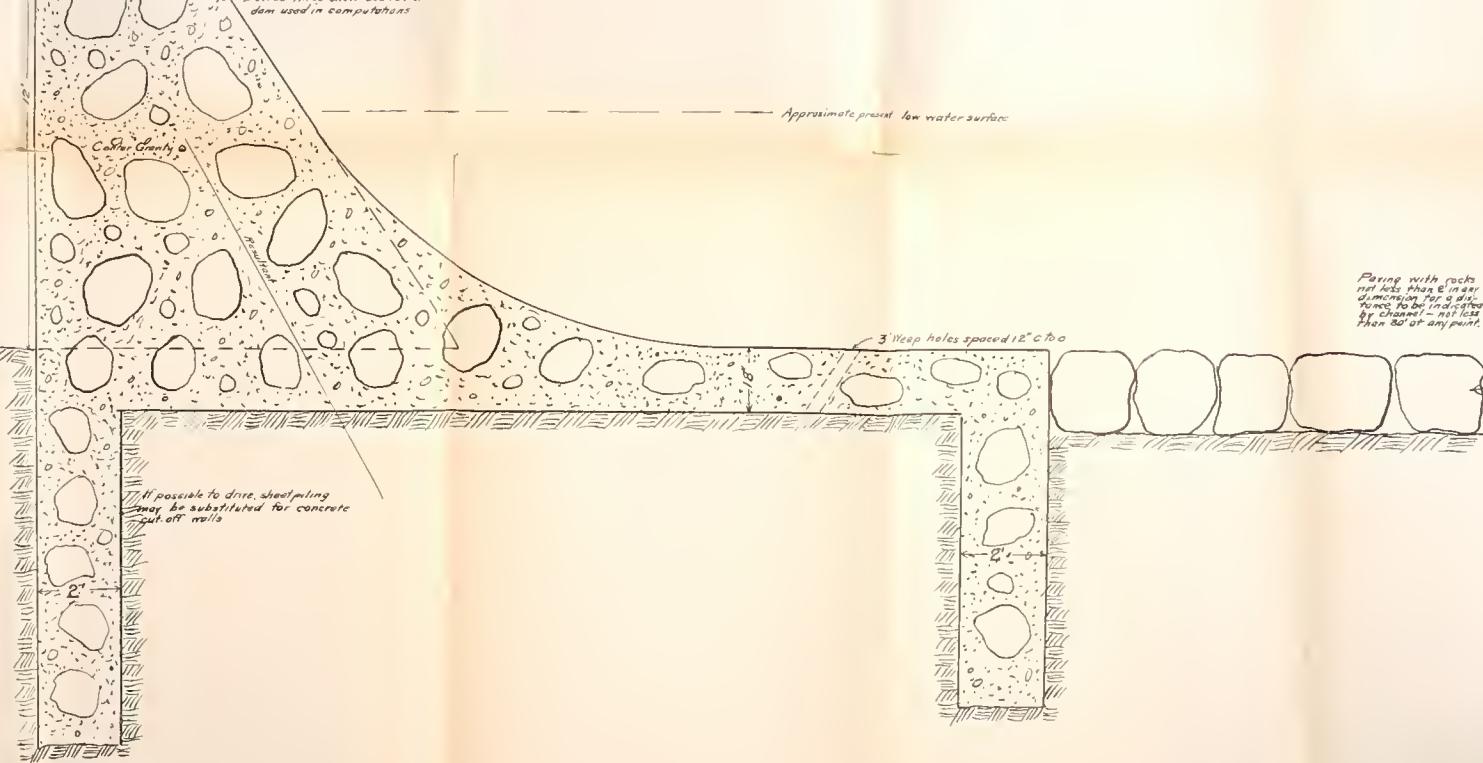
Lower face 1/2:1 slope

6.2'

Head on crest = 8' discharge
or 60,000 cfs
Head on downstream face = 10'
elevation of crest
Weight of concrete = 140 lbs per cu ft

Dotted lines show section of
dam used in computations

Approximate present low water surface



— 10 —
— 10 —
— 10 —

— 10 —
— 10 —
— 10 —

— 10 —
— 10 —
— 10 —

— 10 —